URBAN CLIMATIC DESIGN STRATEGIES FOR A TROPICAL CITY:

An Analysis of Urban Climate and Thermal Comfort Variations in the City of Kandy and its Surrounding

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I declare that this dissertation represents my own work, except where due acknowledgement is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a Degree, diploma or other qualification.

Signed: R.M. Ranatunga 17/01/2004

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This dissertation is a research study that intends to establish the urban climatic design strategies for tropical cities. As study it analyze the urban climate in selected locations of Kandy city. The focus is on the thermal comfort variations in the city and it's surrounding.

In the present scenario people appear to be shying away from the public use of urban outdoor built environment in the city. As a result of harsh discomfort of the places, that mainly affected areas are the streets in the urban environments. By based on the analysis of existing situations of the study, aims to suggested the means of creating a climatically pleasing built environment with improved urban spatial qualities.

This study considered the physical conditions, and historical context and further analyzes the on-site measurements that are responsible for improvement of comfortable out door built environment in the city.

INTRODUCTION

1. Background:

" What makes a good city?

Might be a meaningless question. Cities are too complicated, too far beyond our control, and affect too many people, who are subjected to too many cultural variations, to permit any rational answer.

Cities like continents are simply huge facts of nature, to which we must adapt."

Lynch; 1981:1

However cities provide for an existence for city dweller. The city is also combined with many aspects such as social, cultural, economical, environmental and so on. All these are combined for its spatial environment of the man. Further it provides comfort for people. Physical comfort of the urban environment vastly affects their lives. Presently, the most urban areas have created uncomfortable environment for the human life style.

" It is a common feeling that most urban places are less than satisfactory- uncomfortable, ugly or dull as if they were being measured on some absolute scale..."

Appleyard; 1981:1

Therefore urban public spaces as an outdoor built environment, plays a major role of the city environment.

"Urban public spaces are the stages, where the social interaction, communication, recreation and gathering take place. These are the common grounds where people carry out functional, ritual, activities that bind a community together in the normal routines of daily lives or in periodic festivals"

Stephen Carr; 1992:43

Kostoff [1992], further explained; "The urban public place on the other hand is a purpose built stage for ritual and interaction. Basically the purpose is to create a place we are free to use; and against the privately owned realm of houses and shops."

The city is made of urban masses, and the spaces between these masses form the street, open spaces, public squares, water bodies, trees, parks etc. creates an urban context. Within this urban context man conducts his daily life. While some parts of his daily activities take place indoor, some would take place outdoors. In this case man's out door life has to be taken into special consideration. Such outdoor activities in an urban context is therefore directly influenced by the out door space. The above said, objects form this outdoor space, i.e. urban masses, streets, pavements, parks, squares, trees, water bodies etc.

Therefore in order for man to indulge in his activities, such context must be beneficial to him. The urban street within this urban space must be a place for living, a place where human beings can interact, spend leisure and be free. It must be a place where the power of community life, the public realm is exercised the most. If not so, this will result in the loss of space. The street will be merely a commuting tool that is lifeless, and mechanical. The built form will dominate urban space and create an uncomfortable and undesirable place for man. This will lead to a great loss to the cities and its societies.

Due to the rapid urbanisation process this unfortunate situation is fast emerging. The built form is dominating urban space and is directly influencing the climate and other qualitative factors of urban space. These factors are simply driving man and life away from what is known as the public space, the urban realm.

Urban areas have particular climatic conditions with a higher temperature than the countryside. The urban climate is influenced by solar radiation, building surfaces, trees, water bodies, polluted air particles, that varies according the degree of pollution, the urban

density, the street and shade provide by other elements. The rapid urbanisation in today's context has major effect on urban climate. The urban climate has a major impact on creating a comfortable urban outdoor built environment. This mainly effect for the urban life in urban public spaces within the city.

This study covers the climatic issues that drive man away from urban spaces as a result of harsh discomfort caused by urban centres. In This context Kandy offers a unique case for investigation and drawing up conclusions, aiming at mitigating the conditions. Presently Kandy city continues to undergo rapid densification of its built mass. Its location in the valley of a Mountain range further aggravates the thermal conditions of the place. Architects, planners and urban designers have a great role to play in bringing a stop to this situation. The manner in which thermally comfortable spaces can be created would be by creating thermally responsive built form. Buildings that will be like a living thing, that feel the changes of an environment and adapt to it. How can this happen is the question directed to the Architect, Planner or Urban Designer? It is merely by understanding the relationship between built form and climate and by merely responding to it through buildings.

Topic Explanation:

In the present urban context, man is being defeated by the buildings, the vehicular traffic, the pollution, heat build up, dust, smoke garbage etc. all these are factors that create discomfort to man. Out of which the discomfort caused by, heat, wind, humidity etc, could be known as climatic discomforts. This study is conducted to understand how the urban form creates such discomforts.

This study is based on the context of the Urban Climate in the city of Kandy. It is an analysis of urban form, Urban Climate and Thermal Comfort of streets in the given context. The urban context is looked into with special reference to, its formation and its effect on thermal comfort in the city of Kandy.

This study will derive the relationship between the Urban Form and the Urban Climate in streets, by which one could understand how the urban form affects the thermal comfort of an urban dweller.

Objectives:

The objective of the study is to derive the relationship between built form (along streets such as city centre, near to water body and near to vegetation) and its comfort variations. Also the understanding of the link between built form and climate that makes a space thermally comfortable or uncomfortable could be developed. This would be a base for the formulation of guidelines for the designers.

2. Scope and Limitations:

This study considers the urban spatial variations that affect the thermal comfort. Streets play the major role of the city and therefore it is the most important content of consideration in urban spatial variation. The urban street it self is a vast scope of study and so is the urban climate. However this can be deducted to consideration the height to width ratio of the selected places. Further it discuss and analysis of the urban spatial variations of the given context. Study is limited to a consideration of the physical aspects of the thermal comfort such as the ratio of building height to street width and not considers the building envelope, materials.

The urban streets can be categorised as commercial residential, mixed etc. also the streets can be classified according to their locations, their orientations, form and size. In this study the selected urban environment in a specific physical context, which facilitate the urban out door activities such as streets in the city of Kandy, and the selected streets are commercial streets. Also looking at the area of thermal comfort, it can be directed in many ways and into many depths. The basic thermal comfort would be a measurement of the thermal comfort index. Where the measurements are drawn from the variables, known as the dry bulb temperature and Relative Humidity indexes. Apart from such variable in an urban

climate there are many other variable that would directly and indirectly affect the thermal comfort. Such as tree coverage, air movement, presence of water bodies, dust, pollution, cloud cover, and etc. Therefore thermal comfort condition also has many variables, where due to technical constraints. Some of these variables would be taken as constant, for example the cloud cover, dust, emission of smoke, carbon particles, pollution etc. though such variables are not considered here one must also be aware that these have a great effect on the urban climate. Also the thermal comfort levels of man varies according to there habits, behaviour patterns, clothes worn by them etc. for example a European living in the tropics would be comfortable in a lower temperature variation while the eastern man would be comfortable in a higher temperature variation. Also the time of day and year has effect on climate, where the studies findings would be viable only in that it given scenario during same time of year and day.

3. Justification:

The need for research is important because Sri Lanka being a tropical country many of her urban areas expense problem of intense urbanisation and related thermal comfort variations. " Urban heat island effects" are common occurrences. Therefore, the daily routines of urban population are severely affected.

Every hour, the heat emission and its built up heat, by the way it has been caused for a heat island effect. This has become a harmful factor to the human beings and their daily routines. Initially, people were somewhat unconscious to this development, but with time, this situation has caused a great draw back in the use of public spaces. Due to thermal discomfort, the use of streets tended to be unbearable as time prevailed. In such situation people were drawn away from use of public parks, squares, streets and public transport.

This has automatically resulted in lost spaces and man has dismissed powerful, urban spaces. Also the drawbacks of using less public transport, less pedestrian links etc, i.e. the increased use of

private vehicles has to be faced. This has added to the harmful situation of pollution and stressful climatic conditions. Therefore it is obvious that though mostly unseen by many, the problem is apparent in the existing context. As architects, urban designers and planners it is the responsibility of professionals to step into this crisis at research level, which could be useful in application in building design and street formations. Such research and study would direct development of the urban form in a climatically responsive manner that slowly draws man away from the harmful crisis he awaits according to the present scenario. This obviously is a problem to human life in the urban context.

4. Issues:

The primary characteristic of tropical urban climate is its almost unchanging weather patterns. According to Emmanuel [1993],

"Unlike other climates daily weather pattern dominates over seasonal weather. It is said that in the region all seasons occur within a single day. While, there are no single climatic parameter is excessively high. The combination and the time of occurrence make equatorial climate, unbearable. From a thermal comfort point of view the high air temperature, high relative humidity and lack of air movement is extremely oppressive though such parameter on its own is not thermally oppressive".

The process of rapid urbanisation is adding to the urban mass and lack of care and development in the built form, creates a haphazard development that has no response towards the environment. This situation is an issue that needs to be addressed by architects, planners and urban designers. Due to this factor and the increase in the population there is still more increase in urban density, vehicular traffic, pedestrians' etc. which creates a highly dense street environment. This causes major flaws in the thermal comfort of man. The highly built up street edges traps urban heat and air between the surfaces causing an urban canyon effect. Also the increase in dust particles, pollution also adds to build up of urban heat, which

increases the urban heat island effect. The building density also creates a lack of space for efficient air movement in the urban streets. Lack of open spaces, trees, and urban water bodies again intensifies an already stressful climate. Also it is known that the build up of heat during daytime takes long hours to cool according to heat index of materials in the urban form and lack of wind effect to carry warm air and bring in cool breeze. This ends up in a scenario that heat is built up and trapped where heat reduction or emission becomes a slow process leaving most times of the day and night warm in the urban tropics. This problem can be addressed as two main issues according Emmanuel [1993],"The problem of climate conscious equatorial urban design is therefore two folds: Prevention of heat build-up as the day unfolds and encouraging convective cooling at night."

Thereby the architectural issue would be how to build and design streetscapes that are in keeping with the demand of usable space and also being in response to climatic comfort levels to man at all times day and night.

5. The method of study

General analysis of facts related to thermal comfort of urban built environment and preparation of a format for subsequent research.

The method of study considered the survey of literature preparing to urban growth related urban climatic variations. By analysis of which a framework was formulated which could be adopted to evaluate the conditions of tropical city. The case of Kandy city was studied using this framework

Here this study is analysed by using on- site data measurements of selected locations in the city. In this regard street was considered as the main role to study. Based on this comparative study on Kandy city as a case study, conclusions are to be derived in respect of urban climatic design strategies for tropical cities in given contexts.